Model of the Influence of Magnetic Fields on a Plasma Electrode Pockels Cell*

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In a plasma electrode Pockels cell, magnetic fields can lead to nonuniform charging of the crystal. The fields arise from the current return to the cathode as well as from neighboring devices such as amplifier flashlamps. We have constructed a model which describes the effects of such fields on the plasma. Electrons are treated as a planar fluid moving under the influence of magnetic fields, the electric field of the discharge, electron pressure gradients, and electron-atom friction. The magnetic field from the electrode wires is perpendicular to the plasma sheet. Since the observed patterns tend to change on time scales no faster than a microsecond (the time scale of the driving current), a steady state model has been employed. This consists of the continuity equation for the electron density and the equation for electron momentum balance. The electric field is taken to be that of a positive column with a prescribed potential drop. Because of the large electron thermal conductivity, the electron temperature is considered uniform. With the neglect of convection (justified *a posteriori*), the electron density satisfies a second-order PDE on the plane. This is solved subject to appropriate boundary conditions.

We have considered three applications of the model. First we consider the effects of the magnetic field set up by the return currents above and/or below the plasma. Since opposite currents repel, the electron fluid tends to be pushed away from the wires. It is shown that if the return currents are balanced, the plasma pinching effect is fairly modest and a viable electron density is maintained across the discharge. An imbalance in return currents, however, can lead to asymmetric patterns containing significant electron depletion. These trends are in accordance with experimental indications. Second, we turn to the case of a field oriented along the anode-cathode axis, such as the flashlamp field in the Beamlet reverser configuration. This field is shown to have the beneficial effect of stabilizing the plasma and smoothing nonuniformities in the density profile. Finally, we consider a field perpendicular to both the current and the light beam, which could occur in NIF if the switch amplifier were present. This has the undesired effect of diverting the plasma away from the crystal. In this case a tolerable upper bound for the field is estimated.

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